ISSD NEWSLETTER

Volume I Number 2 March 1988

International Society for the Study of Dendrobatid Frogs

I S S D

A general statement of some of the goals and objectives of ISSD:

ISSD exists to:

: To encourage, stimulate, and wherever possible, facilitate scientific research as it relates to any and all aspects of the study of Dendrobatid frogs; including, but not limited to, ecological studies, toxicological studies, taxonomic studies, and studies concerned with husbandry and captive propagation.

: To unify those individuals who participate in these studies and to provide vehicles of communication for the dissemination of knowledge gained as a result of this research.

: To afford those individuals who participate in programs of captive propagation the opportunity to develop a breeders network to facilitate breeding loans and species trades.

: To assist those individuals who need, or desire, to communicate with foreign government agencies which control access to wild populations of Dendrobatids in countries where they exist naturally.

: To encourage uniformity in record keeping systems for captive propagation programs, as well as uniformity in methods of wild captured specimen disposition reporting.

: To encourage preservation of, and protection for, populations of threatened or endangered Dendrobatid species; while at the same time preserving opportunities for limited access to those populations by individuals with legitimate research interests.

: To encourage the establishment and maintenance of stable and genetically diverse captive populations of endangered or threatened species.

Note From the Editor:

here is more information about *Dendrobates auratus* in this newsletter than exists in any other single volume that I am aware of. In as much as this is true; one of the prime objectives of the newsletter, and of **ISSD** itself, has been met. It is my hope that after reading the articles in this volume you will be more knowledgeable about this species than you were before. I am very pleased that people have felt inclined to present their work for publication in this newsletter. In my view, this is a validation of its worth. I hope that in the future many people will view this newsletter as a suitable medium for dissemination of their knowledge.

As editor of the newsletter, I am always concerned about having enough material to put together a good newsletter. There are basically only two options open to me. I can get material from the readers or I can write it all myself. I am sure that you do not want to have a newsletter that is written by just one person; and I can assure you that I do not want to put out such a newsletter! Therefore, I am calling on you, the readers, to be thinking towards future editions with an attitude that asks "what can I contribute". To facilitate this ,I am herein giving a list of the next three edition's "featured frogs".

The May, 1988 edition will feature not just a single species but rather a closely related group: the quinquevittatus complex. Although *D. quinquevittatus* is present in some U.S. collections, *D. reticulatus* and *D. fantasticus* are conspicuous for their absence in the U.S.. Therefore, I hope that some of our European members who are experienced with these two species will put the pen to the paper in order that we all might learn from their experiences. I do not know of anyone in the world who keeps *D. vanzolinii* in their collection, I am personally very interested in learning more about this species!

The July, 1988 edition will feature *D. azureus* and the September, 1988 edition will feature *D. histrionicus* and *D. lehmanni*.

Some people have expressed concern about publishing a paper in English when they do not feel completely confident of their command of the language. I am of the opinion that papers in the newsletter should be published in English whenever possible. Although it is quite common for Europeans to read English as a second language, most Americans are not familiar with the European languages. In the first edition, the paper by the Zimmermanns had an abstract in German; this practice should be continued. I do not mind printing papers in a language other than English, but my ability to edit them is very limited. Papers submitted for publication that are not written in English must be word perfect; they will be reformatted to fit the style of the newsletter but the actual words will be published exactly as I receive them. Also such papers should have an English abstract. If someone wishes to publish a paper in English but needs some help, I will be happy to be of assistance. Send your work to me in rough draft form and let me make suggestions for refinements. This of course must be done well in advance of the date of publication of the issue in which you would like it to appear. It is easier for me to work with rough drafts if the papers are typed and the lines double spaced.

"Displaced Frog Finds Niche in Paradise"

Subtitle: "This Buds for you!"

by William Perreira & Dale Bertram

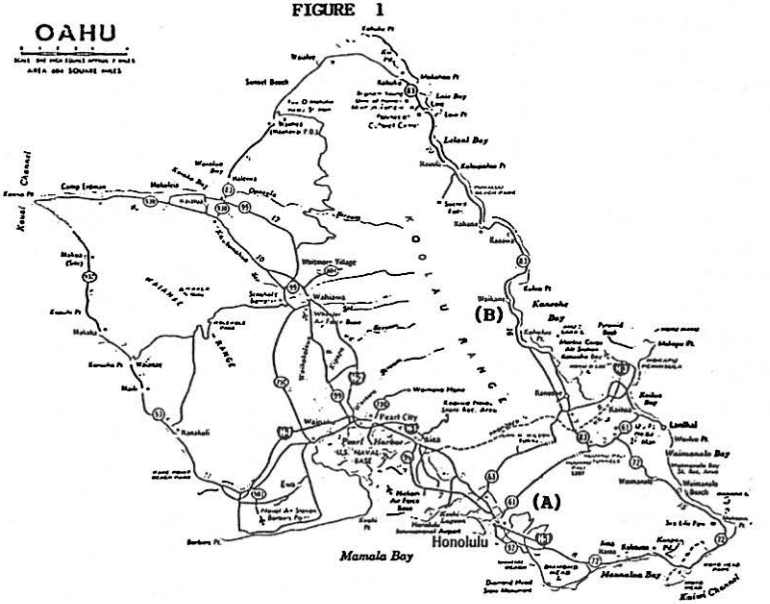
Situated some 4000 km from the nearest continental land mass and 1600 km from the nearest high island group, the Hawaiian Islands are the most isolated major archipelago in the world. Over the millennia the vastness of the Pacific Ocean has proven to be a formidable barrier to the colonization of these islands by plants and animals. Yet, in Hawaii one can find 2000 species of endemic lower flowering plants, 1000 flowering species, 2500 land and marine mollusks, 8000 insects, over 600 fish, 100 birds, one species of bat and one species of seal (Zimmerman, 1948; Sugden, 1987). However, a native herpetofauna is virtually non-existent in the archipelago.

Apparently just three species of sea turtles and one sea snake comprise the entire indigenous herpetofauna of the islands. A few species of lizards may have arrived on their own as rafters on floating debris, but more probably they arrived as stowaways in the canoes of the early Polynesian settlers. Tinker (1938, Sec. ed. 1941), Oliver and Shaw (1953), Hunsaker and Breese (1967), and McKeown (1978) each list between 22 and 23 species of reptiles and amphibians from Hawaii. Over time the number of species present tends to remain fairly constant, but composition of the different types of species tend to change as new species become established and old ones disappear. Relative newcomers include the Gold Dust Gecko (*Phelsuma laticauda*) and Jackson's Chameleon (*Chamaeleo jacksoni*). Most of our lizards and freshwater turtles were either accidentally introduced, released as food animals, or are escaped pets. It has been speculated that the Gold Dust Gecko was intentionally introduced by an anonymous admirer. All of the amphibian species have been intentionally released either as potential sources of food or as biological insect controls. The Green and Black Dart Frog, *Dendrobates auratus*, is by far the most colorful and charming of those species brought in for insect control.

In December of 1932, D.T. Fullaway released 206 individuals of what he thought were *Dendrobates tinctorius* in upper Manoa Valley (el 130 m) on the leeward side of the island of Oahu, Tinker (1938;1941), Oliver and Shaw (1953). Later, additional plantings occurred on the windward side of the island at Waiahole Valley, some 15 km from the original release site at Manoa (Figure 1). Emmett Reid Dunn later noted that the Hawaiian *Dendrobates* were *auratus* rather than *tinctorius,* and that they had been collected either from Taboga or Tobogilla Islands in the gulf of Panama (cited in Oliver and Shaw, 1953). It was hoped that the tadpoles of this species would assist in the control of mosquito larvae and thus help contain any mosquito borne diseases should such outbreaks occur. In the past fifty years, both populations have managed to thrive but neither has been able to extend its range much beyond the floors of the valleys in which they were originally released.

Adults of *D. auratus* typically are moderate

FIGURE 1



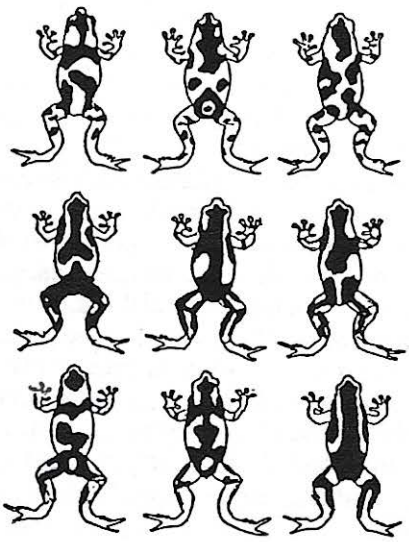
RELEASE SITES OF *D. auratus*
ON THE ISLAND OF OAHU
(A) = Manoa Valley
(B) = Waiahole Valley

in size (SVL 25 - 33 mm) with very attractive mottled camouflage patterns. A flat, light metallic green or iridescent yellowish-green pattern of splotches is mixed with bars and/or spots of brown or black; this adds up to a most striking effect, particularly when one inadvertently encounters one of these frogs in the field. Typically most individuals have bars of black or dark brown running longitudinally or laterally across the head and the trunk of the body (Figure 2A). More rarely one encounters individuals which show a spotted pattern rather than the typical barred pattern (Figure 2B). Usually the basic adult pattern can be seen on the tadpoles as they are about to complete their metamorphosis. In a few specimens that I have reared from wild collected tadpoles, a pattern of black spots symmetrically positioned on the lateral sides of the abdomen and the head appear in areas that were previously entirely green. These markings begin to appear as the frogs reach maturity at about one and one half years of age (Figure 3). It has been demonstrated (Bertram, unpublished report, 1987) that crossing the typical barred pattern with the atypical spotted pattern predictably results in F1 frogs with these late developing markings.

The most desirable habitats for *auratus* are in the highly disturbed scrub forests at the foot of

the valleys (el 60 m) where annual rainfall averages approximately 160 - 200 cm. They seem to show a preference for garbage dump sites! It is here that beer cans, old cooking pots, abandoned automobiles, and other debris positioned so as to collect stagnant water, provide havens for tadpoles. Who, other than a frog collector, would look upon these eye-sores filled with filthy water as a blessing in disguise? In and around these containers the mosquitoes and their larvae abound, and so does *auratus*. There are no naturally occurring native plant species which have a tank of water in their leaf axils which would be large enough to support a tadpole (although a few do house damsel fly naiads). Ulman (1967) found the tadpoles of *auratus* in the leaf axils of the introduced cultivar "ape" (*Xanthosoma robustum*). Tree holes are unsuitable as tadpole development sites due to their relative rarity. In order to perpetuate itself, *auratus* has become a commensal species of man in Hawaii. It has been unable to spread far from its original release sites due to the absence of tadpole microhabitats in the contiguous areas; the tadpoles are abundant in garbage with standing water but not so elsewhere.

FIGURE 2A



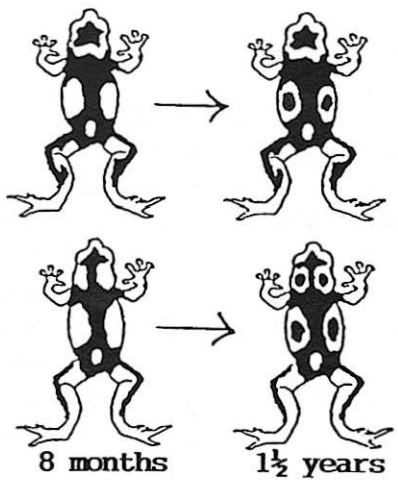
VARIATIONS IN THE DORSAL PATTERNS OF *Dendrobates auratus* Typical "Barred" Pattern

FIGURE 2B

VARIATIONS IN THE DORSAL PATTERNS OF *Dendrobates auratus* Typical "Spotted" Pattern

It is ironic that a species introduced by man, and perpetuated in a commensal relationship with man, may eventually face extinction from the islands because of mans activities. Any animal which occupies a very restricted geographical range is especially sensitive to the effects of collecting. Although it is illegal in Hawaii to collect and export "introduced species", a great many of the "wild caught" *auratus* offered for sale on the continent come from Hawaii. *Dendrobates auratus* is the most commonly produced species among dart frog breeders: there is NO reason for a market to exist for wild caught specimens! **ISSD** members are especially urged to act responsibly, in regard to the protection of Hawaiian *auratus*, by insisting that the *auratus* that they purchase be captive bred.

FIGURE 3



Development of Distinctive Dorsolateral Spots

In the early morning hours, or following a rain, it is not unusual to see one or several frogs hopping about amidst the debris. The males emit a soft buzzing courtship call while remaining hidden amongst the litter, or out in the open, but never very far from a hiding spot. I have seen up to three females pursue and fight for the favors of a single male. I have yet to observe the entire courtship ritual in the wild. Breeding probably occurs year around with the greatest activity concentrated during our rainy season (November - April). During the hot dry summer months the adults resort to hiding under leaf litter and debris, venturing out only during rains. In captivity, a clutch of eggs (typically four to eight) usually takes between twelve and eighteen days to hatch. Metamorphosis is complete in about six weeks on a diet of termite nymphs. The development times may vary in the wild due to variation in the temperature, humidity, and availability of food. Captive raised frogs mature in one and one quarter to one and one half years on a diet of vitamin fortified ants and termites.

Much remains to be studied concerning the biology and ecology of *Dendrobates auratus* in Hawaii. Virtually nothing is known of its relationship to its habitat; what does it eat? Who eats it? Are the tadpoles really an effective form of mosquito larvae control? Comparison studies with the parent population in Panama should be undertaken to ascertain if the Hawaiian population has undergone any evolutionary changes relative to enzymatic or skin toxin profiles since its introduction into Hawaii.

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A Day in the Life

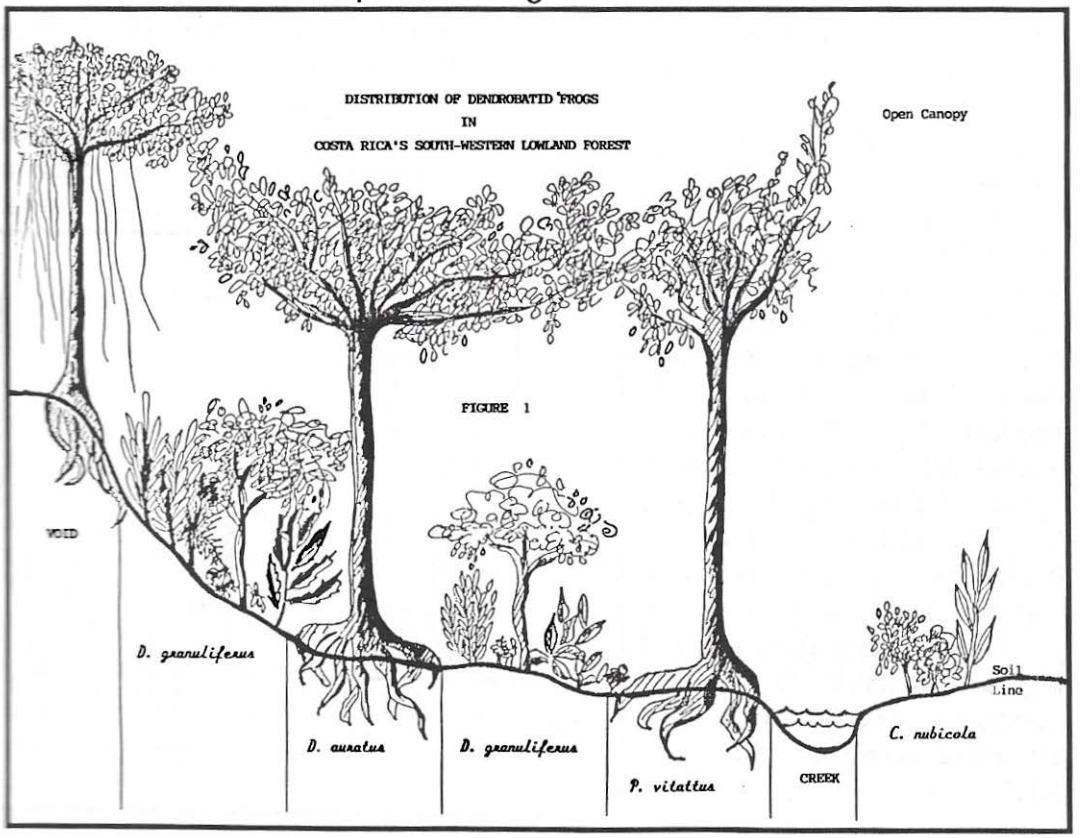
Bruce I. Hiler
Biologist
Steinhart Aquarium

If we look at the many books and articles about dendrobatid frogs, information about habitat usually lists a geographic distribution, elevation records, and some reference to "lowland forest" or "rain forest". Although essentially correct, the frogs actually inhabit a very specific niche or microhabitat. The microhabitat of the species is what makes it ecologically unique and separates it from the thousands of species of plants and animals that make up the very complex and diverse living system found in a tropical forest. To better understand an animal's way of life, we should study its unique ecological niche. The following information is a generalization of data collected during several months of field work undertaken from 1983 to 1987, and presents a stereotypic look, so to speak, at a "Day in the Life" of *Dendrobates auratus.*

The study sites are confined to primary and late secondary forest, although *D. auratus* is found and even thrives in disturbed areas, such as cacao plantations. Information from these disturbed areas is extremely different and does not truly reflect the frog's natural history. Using Holdridge's World Life Zone System (1967), the forest study areas fall into two ecological classifications. On the Caribbean side of Costa Rica, the forest type is Tropical Moist Forest. It averages three meters of rainfall annually. The study sites on the Pacific side of Costa Rica are the Tropical Wet Forest Zone and enjoy an annual four meters of rain. By Holdridge's standards, there is no low-land rainforest in Costa Rica, which by definition, requires eight meters of precipitation a year. Even though it is not true rainforest, the drier Caribbean sites' three meters of rain per year still amounts to nearly ten feet of water! Even in the "dry season" (February - March) a monthly rainfall is over half a foot (Coen 1983). The dry season rains usually fall daily in the late afternoon, in the form of a short convection rain downpour. The convection air currents and associated cloud formation also account for an annual average sunshine of only five hours per day. During the wet months (November - January) you can expect over a foot of rain per month. This occurs when storm fronts team up with convection moisture. I have had knee-high rubber boots literally fill up while being worn in twenty minutes, have enjoyed nearly zero visibility while driving, and have had many "water-proof" items and "rain-proof" tents well washed!

The moist climate and shallow soils support the buttressing trees that *D. auratus* calls

home. The frog shows no species preference for the trees it inhabits. Tamarind (*Pentaclathra macroloba*), Bloodwood (*Pterocarpus officinalis*), Mahogany (*Sweitenia macrophylla*) and any of thirty or more species of trees that have thick, tall buttressing roots are utilized by the dendrobate. However, the frog is specific for the size of the tree and which part of the tree it inhabits. Minimum size of the tree must be approximately 30cm d.b.h. (diameter at breast height). More importantly for the frog, the buttressing complex must cover at least six square meters of forest floor. This floor area supports only one single frog. Much larger trees with buttresses covering as much as thirty square meters also house only one frog! (Figure 1). Along the soil line of the buttresses are numerous holes and tunnels. Created by rain, rodents, tarantulas, or land crabs, these holes are the primary retreat for *D .auratus*. The frogs know their homes well and usually have a preference for one or two deeper caverns. Males will call from the edge of a buttress up to three meters above the forest floor. This gives the frog a good view of potential mates and nosey field biologists. The buttresses often form water basins for tadpoles, although other water reservoirs are also used



(Silverstone 1975). I have observed a female with a peculiar color pattern that resided in the same tree for four years. She has been seen courting males in neighboring trees, but always returns to her home, alone. In contrast, disturbed habitats can house many frogs in a small area. A hotel garden I know of is home to at least twenty *D. auratus* in a six square meter area vegetated with Asian bamboo (*Bambasa vulgaris var. striata*). The closed canopy information supports the one frog - one tree ratio. I have no easy answer for the difference in population density between primary and disturbed habitat. Since the frog evolved in primary forest, we can assume the one to one, frog to tree, ratio is its natural choice.

All my field data (over 500 hours) for *D. auratus* can be divided into five types of activity that occur between dawn and dusk. "Resting" or staying at home base, under a buttress, out-of-sight, constituted 50% of daily activity. "Foraging" or hunting for ants and termites constituted 30% of daily activities. This is something *D. auratus* does more than any other Costa Rican dendrobate. The other species seem to eat more by chance, while engaged in other activities. "Courting" behavior is defined by two or more frogs interacting around the same tree. This accounts for 15% of daily activity. They engage in pre-mating displays, calling, and females wrestling over a male. "Calling" or males vocalizing from a tree, accounts for 10% of the males activity time. The remaining time falls into the undetermined category, which usually occurred because I was observed and the frog sought cover before I could determine its behavior. I have no information on breeding, tadpole transport, or even a sighting of a subadult frog on the study sites. I think the reasons for this are a combination of: 1.) The rarity of the events, 2.) Shyness of the frogs, 3.) Seasons the data collection occurred in, and 4.) Simple bad luck. Figure 2 shows typical diurnal activity versus rest in a hypothetical ten frog plot. Again, this is a composite of all my *D. auratus* data. The information compiled shows a tendency toward early morning activity and high activity levels after, but not during, rains; i.e. 80% of the frogs are active between 0830 and 1030.

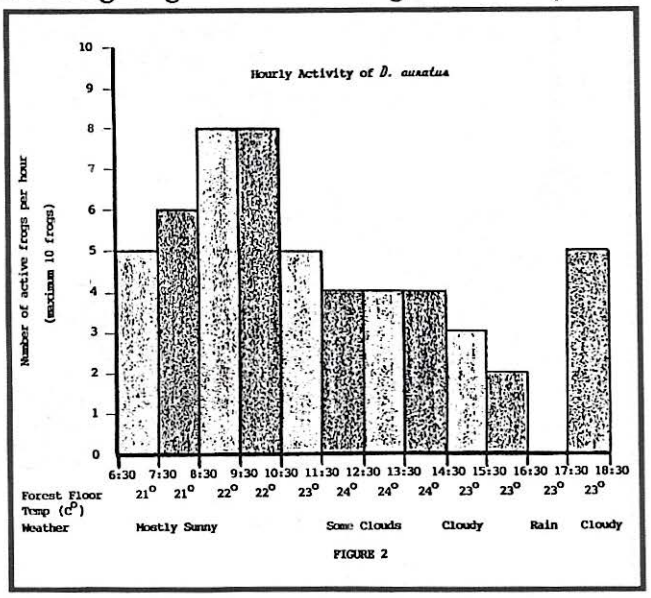


FIGURE 2

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Important Notice:

The first annual meeting of **ISSD** will be held in conjunction with the **12th International Herpetological Symposium On Captive Propagation and Husbandry**. The symposium is being held at the Holiday Inn-Jetport (Telephone # 202-355-1700), at the Newark International Airport, Newark, New Jersey. Registration for previously unregistered attendees and sign-in for pre-registered attendees will begin at 1:00 PM on Wednesday, June 15th, 1988. **ISSD** will be hosting a workshop on "Husbandry and Captive Propagation of Dendrobatid Frogs". This workshop will begin on Saturday, June 18th, at 1:00 PM and it will last until interest has been exhausted. After the workshop we will have some brief organizational business to conduct.

Anyone who is coming to the symposium who would like to arrange specimen trades may feel free to use the classified ads section of the May newsletter to advertise their desires.

Anyone living in Germany or Holland who is planning to attend the symposium, please contact Dale Bertram; I would like to arrange for someone to transport frogs for me from Europe. If you desire additional information about the symposium you may contact David Hulmes at 201-427-0768. See ya there!!

Dendrobates auratus; Breed 'em !!

The following are a few ideas and methods that have worked well for me in the keeping and breeding of Dendrobates auratus.

by Dale Bertram, M.D.

First Things First: Task number one is obtaining healthy, breeding quality animals The frogs with which I have had the greatest success have been wild caught specimen from Hawaii. Healthy adult females usually are fairly easy to sex, they are slightl larger than males and usually quite plump. Males are somewhat more difficult t diagnose correctly. If the frogs are adult size and well nourished, I have had abou a sixty percent rate of accuracy diagnosing the males. An adult male is usuall smaller and leaner than a female. Often the toe pads of the second and third digit of the front feet are noticeably wider in the males than they are in the females Female frogs do not make repetitive vocalizations. Although they are capable o and occasionally do make sounds, they do not "call". If a frog is noticed to be makin repetitive buzz calls, it is most assuredly a male. Captive bred specimens ar preferable to wild caught ones. It is becoming increasingly easier to find CB frog now that this specie is being bred by an increasing number of breeders.

Population Density: I am convinced that this is a key factor! I kept seven adul frogs (2:5) in a fifteen gallon aquarium, under what I thought were fairly idea conditions, for nearly a year without so much as a single buzz call, and of cours no eggs. Other than the complete lack of interest in breeding, they appeared t be doing very well. I transferred this breeding group, minus two of the females to a fifty breeder aquarium (36"x18"x18" - 92cm x 46cm x46cm); within a few day I heard the males calling, and apparently the females heard them also because i was not long after that I began to find clutches of eggs almost daily.

Climatic Conditions: My frogs are kept in a special "hot room" which I constructe in my basement. The room is completely insulated, walls and ceiling, and lined wit

plastic. A non-fume producing heater (silicone oil radiator) is set on a timer to heat the room to approximately 84 degrees F (29 degrees C) from 6:00 AM to 6:00 PM. After the heater turns off, the temperature falls over night to approximately 78 degrees F (26 degrees C) in the summer and 72 degrees F (22 degrees C) in the winter.

I try to keep the humidity as high as possible (80-90%), using a rolling belt type room humidifier which runs constantly on a low fan speed during the "wet season". Keeping the humidity high in the room itself allows for the use of screen tops rather than glass tops on the tanks, improving ventilation. Good ventilation is highly desirable; I have constructed some air ducts made of styrofoam glued to the walls. The ducts run along the walls behind the tanks at the level of the tank tops. Near each tank I have cut a hole in the duct so that air blows out across the top of the tank. The heater and the humidifier are kept under an L shaped cabinet, each under one wing of the L. At one end of the cabinet there is a small squirrel cage duct fan (rolling drum type) which blows into the styrofoam air ducts. At the other end of the cabinet there is an air intake vent. Room air is sucked in, flows past the humidifier and the heater, then is pushed out to the tanks. Styrofoam is inexpensive and the fan was salvaged from an old discarded air conditioner, so the whole set up was very inexpensive to build. When the fan is on, the leaves of the plants in the terrariums can be seen gently stirring in the breeze. The ventilation fan and the heater, both on the same timer, run twelve hours a day.

I do not believe that lighting is a crucial factor. My personal experience in the jungle where these frogs live naturally, is that it is fairly dark even on the brightest of sunny days. This is however, a controversial topic. Some experienced and very successful breeders emphatically claim that lighting is very important. I use double bulb florescent lights equiped with Vita-Lite bulbs suspended about fourteen inches above the tank tops. The lights are on fourteen hours a day (on a timer) and I do not vary the photoperiod.

The terrariums themselves are home made. I preferred this because I wanted a hole in both the back glass and the bottom glass. It is quite difficult to drill a hole in the glass of a tank which is already glued together with silicone sealer. Aquariums with holes made in the glass can be purchased, but it is more expensive and one usually has to wait several weeks for the special ordered tanks. It is much quicker and less expensive to order the glass from a glass dealer with the location

and size of the desired holes specified. The tanks are easily set up, held togeth temporarily by tape, and sealed with 100% silicone rubber. Do not buy the silico rubber that is sold in pet shops as aquarium sealer, as it is very expensive. T same sealer can be purchased in a building materials supply store in caulking g size tubes for a fraction of the cost; just be sure it is 100% silicone rubber. Ea of my tanks has a 1/2" hole on the back glass through which runs a piece 1/2" PCV pipe. Connected to this is a piece of airline tubing which runs to a sma water mister. These can be found among micro-irrigation equipment in either florists shop or a garden supply store. The brand I use is Misty-Maid. All the tank are plumbed together on one line of non-softened tap water; each tank intake lin is isolated from the main line by valves. The water supply is controlled by a seve day water timer (Nelson Water Computer). The water mists twice a day durin the "wet season" (September through May) and once every third day during the "dr season" (June through August). The water stays on for eight minutes,long enoug to give the entire tank a good soaking. Along the inside bottom of each tank there is a piece of 1/2" PCV pipe that has numerous holes drilled in it. This exits the tank through the hole in the glass and drains into a common collecting pipe which is routed into the sewer. There is a layer (about 5 cm) of "lava rock" over each tank's drain pipe. This promotes good drainage of the substrate (a mixture of equal parts potting soil-sphagnum-perilite). The combination of daily misting and draining tends to leach the soil and prevent the buildup of organic wastes produced by the frogs. Good drainage is also crucial to the growing of plants, especially bromiliads and orchids.

The "Honeymoon Huts": In my larger tanks I have built little elevated platforms by gluing flattened tree bark slabs into the corners. Because these are always wet, they tend to sag down over time. The free corner of the bark slab is supported from below by a thin strut to prevent this. These bark slabs are a good place to plant spider plants which will grow roots into the crevices of the bark, the plants themselves will hang over the platform and down into the tank for a nice effect. The "honeymoon huts" are placed on these elevated platforms. The huts are constructed by cutting a large coconut in half, each half serving as one hut. Of course the meat of the coconut must be removed and a small doorway cut to allow the frogs to get in and out. The huts are inverted over a petri dish that has a small

amount of water in it. A plastic or silk artificial leaf can be glued over the top of the petri dish so that it is suspended just above the water. This is where the frogs like to breed, the females laying the eggs on the artificial leaves. I have not noticed any territorial activity among males of D. auratus. A courting male simply selects an available hut and then from within the hut attracts a female with a low pitched buzz call. I have also observed males calling from open sites in the tank; the responding female is then led to a hut which the male has selected in advance. The huts are checked daily during the breeding season (December through June) and any eggs found in unoccupied huts are removed; this is necessary because a female encountering the eggs of another female will often eat them. If a male is seen in the hut along with the eggs, it is best to wait until the next day to remove the eggs because the male does not always fertilize them immediately as they are deposited by the female. The huts are effective because they provide safe places of refuge; this is an important point! Frogs will not breed in an environment where they do not feel safe and secure. The tanks themselves are densely planted to provide numerous hiding places. The frogs are disturbed as little as possible, especially if the males are heard calling.

Feeding: Dendrobates auratus will not breed unless adequately fed, the same is true for most captive animals. I feed my frogs all they can eat; during the breeding season I try to feed them daily. The mainstay of their diet is vitamin dusted crickets. Crickets are easily cultured in ten gallon tanks using ordinary sand as a substrate. I put in enough crickets so that when I feed the frogs the next day a few uneaten crickets remain in the tank from the day before. I supplement the diet with fruit flies, ants, aphids, and other small insects.

Breeding: Although D. auratus may show some breeding activity all year around, there is a definite breeding season (December through June). How the frogs know what time of the year it is outside my basement is a mystery to me. Since they are not provided with any environmental clues such as photoperiod variation or temperature variation it must be due to some internal clock. My manipulations with the "wet season - dry season" cycle have been made in response to my observation that they breed seasonally. The cycle is timed with, but is not the cause of, their natural seasonal breeding cycle. Changing the misting cycle does not effect breeding significantly unless drying is excessive. I have observed that it is possible

to induce breeding in reluctant groups by putting them through a prolonged fast and drying period. The resumption of feeding and misting is followed by breeding activity. I am not sure of the relative importance of the fasting verses the drying

Egg and Larval Care: When I notice eggs in the huts I remove them if no males are present. The eggs are gently scraped from the artificial leaves into a sterile petri dish. Water is put into the dish so that the egg mass is wet on its edges but is not submersed in, nor floating on, the water. The water is changed every third day. The eggs have a black side and a grey side. They should remain black side up after transfer from the leaves to the petri dish. Healthy fertile eggs have a clear jelly mass surrounding the entire clutch. Infertile eggs are individually surrounded by a thin jelly capsule. If the eggs do not look good initially, then they are not good. I can never bring myself to throw away fresh eggs but whenever I have separated out eggs that looked suspicious (irregular shape or grey flecks in the black) those eggs have always proved to be bad. After a few days there will be obvious changes in the eggs. The black yolk elongates slightly and a faint blackish grey line appears to transect the egg. This line continues to elongate and progresses out from the edge of the yolk as the developing tail grows. After about fourteen to eighteen days the eggs hatch into free swimming tadpoles. As soon as they hatch the tadpoles are transferred to individual plastic cups which contain about 50 cc of water. The tadpoles, which are cannibalistic, are raised separately. Tadpoles are fed a variety of foods: frozen brine shrimp, macerated beefheart, Formula II High-protein Tang Food, and frozen blood worms. I do not use dried flake type fish food because I have noticed that occasionally tadpoles will develop large gas bubbles in the gut on flake food; this condition has been uniformly fatal when encountered. I try to change the water every day. I do this by sucking up the water with a 50cc irrigation (wide mouth) syringe and replacing it with tap water of a similar temperature. I have not noticed any ill effect from using water right out of the tap. On a few occasions I have let the water go a few days and even though it was obviously foul, the tadpoles seemed to come to no harm. I still however, recommend changing the water frequently. After about three weeks the hind legs become visible and from that point on grow rapidly. After about five to six weeks the developing front legs are visible within the so-called "skin window". I have had a few tadpoles in which the skin window distended out abnormally into a fluid blister, through which could be seen small non-motile front legs; this is the spindly leg syndrome (SLS). I have

found that if the fluid blister is surgically excised (the enclosed fluid seems to be under pressure) the front legs will eventually go on to develop normally. To my knowledge this is the first successful "treatment" of SLS, which if left untreated, is almost always fatal. The tadpoles remain entirely black until the emergence of the front legs, after which, the tail reabsorbs over the course of about a week and also the characteristic metallic green markings appear. When the tail begins to reabsorb the tadpoles are transferred to small containers that have gravel banked up on one side so that they can get out of the water. They do not eat from the time the tail is about two thirds reabsorbed until about one week after metamorphosis is complete, at which time they will begin to feed on fruit flies and newly hatched crickets. The young are raised in groups of ten to fifteen in ten gallon terrariums. Frogs which seem to be failing at competition for food are removed and raised individually.

Using these techniques I had one hundred and ten eggs from a group of eight frogs (3:5) during last winters breeding season. From these I raised up eighty eight frogs (80%). Most of the losses were from eggs which looked bad right from the beginning, and most of these were from clutches produced toward the very end of the period of productivity. Of those eggs which began development I lost only three tadpoles. Two died early in development of unknown causes and the third was killed when I accidentally sucked it up into the syringe during a water change.

Conclusion

I would not want to suggest that elaborate systems are necessary for success with breeding D. auratus. This paper describes my system; but it is only the general principles which are important. The same conditions can be duplicated in a simple fifteen gallon terrarium with a little thought and ingenuity. In summary; D. auratus should be provided with a densely planted terrarium, plenty of hiding places, a secluded breeding site, a low population density, warm air temperatures, high humidity, adequate ventilation, good lighting, and plenty of food. Above all, leave them alone! If you cannot resist the temptation to roust them out of hiding periodically to see them, you will not be seeing many eggs.

The Breeders Forum

In ***Volume I Number 1*** there was a question raised concerning treatment of intestinal nematode (round worm) infestations in wild caught dendrobatids. I have two things to report on this subject:

Dr. Peter Weygoldt, Professor of Zoology at the Albert-Ludwigs-Universitat, Freiburg, West Germany writes:

"Treatment of intestinal nematodes is not difficult. I use Panacur, *which is manufactured by* Hoechst Pharmaceuticals. *Its effective agent is* Fenbendazol. *It is produced for treatment of nematode infections in live stock, such as pigs, cows, pigeons, etc.. I suppose that a similar drug can be obtained in the United States. It comes as a solution or as a 4% powder, which is what I use.*

Panacur *is supposed to be tasteless. It kills nematodes but is not (or at least only in small amounts) systemically absorbed by the frogs. Therefore, it is effective only against nematodes infesting the alimentary canal, not against lung worms which are a much more difficult problem. Fortunately it cannot be overdosed. In serious cases I administer a suspension of it with a pipette into the stomach. In Dendrobatids I simply dust the flies (Drosophila in small species, Musca in large species) and feed them to the frogs, which have not been fed for a couple of days.*

In this way I treat all new frogs, and I repeat the treatment after one or two months and then once or twice a year thereafter".

A member (who wishes to remain anonymous), who is a professional parasitologist, did postmortem exams on some of my dead D. pictus and made the following rather surprising observations: The worms that were infesting the frogs were not nematodes but rather, annelid worms! There have been only rare reports of parasitism among worms of the family annelida (common garden earth worms are annelids). An exact specie identification awaits the analysis of live worm specimens. This, unfortunately, awaits warmer weather, suitable for shipping. The following treatment protocol was recommended as having been successful in the past in treatment of worm infestations of this type: 0.1cc of a 0.03 mcg/ml solution of Praziquantal, or 0.1cc of a 10.0 mcg/ml solution of Ivermectin, both in 10% aqueous propylene glycol and both administered orally using a small pipette or soft

catheter. Effectiveness of treatment is determined by watching the water in the petri dishes from the terrariums for the presence of worms.

The medications mentioned in this column are available through your local veterinarian.

Interestingly enough, postmortem examination of the dead frogs showed that death was due to some type of toxic injury to the liver rather than to injury from the worms.

Another member, Mr. Peter Keane of Bronx, New York submits the following questions and awaits your answers: *"Which matters more, tank height or substrate surface area, when constructing a set up for Dendrobatids? * Can different species of Dendrobatids be mixed successfully in a community tank? * Could I use distilled rather than tap water for misting the terrarium and for rearing the eggs and/or tadpoles?*

The success of this column is directly dependent upon you, the reader. We need both questions and answers to keep it going. Please send your questions and answers as soon as possible after you receive the newsletter so that they can be included in the next edition.

Historical Anecdote

Mr. J.R. Dinardo sends in an interesting historical anecdote especially germane to our discussion of *Dendrobates auratus*. The quotation is from a book entitled A Naturalist's Scrapbook by Thomas Barbour, Harvard University Press, 1946.

"Dendrobates"

"I wish I could give you a real picture of Taboga Island as it was when I first visited it. Beautiful and serene it had been since first it caught the eye of the first Conquistador who sailed the blue waters of Panama Bay, and a charming little week-end resort it certainly was when Rosamond and I went there nearly forty years ago... Now curiously enough, after all these years - for remember, this trip took place in 1908 - two things stand out sharply in my memory... I first recall that there was a colony of bats in one of the great Sapte trees growing on the front lawn of the hospital... The other picture that flashes to my mind's eye now is Dendrobates. I have never seen this beautiful little frog so abundant as it is along the banks of the stream near the village of Toboga. The species Dendrobates tinctorius *occurs in an infinity of wildly different color varieties in the various places where it lives, but the one found here is coal black, lustrous shiny black, with marbling of the most vivid metallic green, glittering wet-paint green - and the whole effect is totally different from that of any other amphibian I know. I soon learned something about Dendrobates too; after catching the first specimens which I saw I rubbed my finger in my eye and thought I had put it out, for this devilish little frog secretes a poison which is unbelievable irritating and active. It is known that in some localities it was used as an arrow poison by the Indians. They simply tortured the poor little frog with the point of a burning stick and then rubbed the tip of the arrow on the slime which it exuded. In Brazil, the slime is used for another purpose. The Indians of the Amazon have found that the skin of the toad rubbed on the skin of parrots from which the feathers have been plucked makes all sorts of fantastic birds which find a ready sale. The parrot acquires yellow instead of green feathers after this treatment and thus strange "contrafeitos" are produced."*

Further Observations from the Study of Inbreeding of *Dendrobates auratus* at the Brookfield Zoo

Joyce Peterson, Keeper - Department of Herpetology
Chicago Zoological Society, Brookfield Zoo

Introduction:

Three specimens of *Dendrobates auratus* were donated to the zoo in 1978. Whether they originated in Costa Rica or Hawaii is not known with certainty, but their neotropical origin is most likely. Presently, we still have one of the original frogs, a male, in our exhibit colony. We also have a second colony which is completely inbred and of the F4 generation. Our breeding program has been designed to observe the possible deleterious effects of inbreeding in this species, especially as it affects reproductive behavior and viability.

Husbandry:

Both colonies are housed in cages equiped with cool-mist vaporizers. They receive four fog-like, hour long, mistings during a twenty four hour cycle (0700, 1200, 1900, 2300). Their basic diet consists of pinhead-sized crickets dusted with a mixture of powdered calcium and Brewers yeast (figure 1).

The frogs are allowed to tend the eggs and transport the tadpoles to a small water container situated especially for this purpose. In the inbred colony, the keeper moves any tadpoles which have not been transported by the adult frogs within a day or so of hatching. This is to maximize the tadpole yield for observation purposes.

The tadpoles are raised singly in individual containers. Each morning they are given some algae, egg yolk-gelatin, and a cricket. Algae is obtained from a local pond and cut into small strands. The egg yolk-gelatin is a suspension of 60% egg yolk to 40% unflavored gelatin (Figure 1). The cricket is about the size of the tadpole's body and is offered torn and without additives. Exposure to ultraviolet light is provided by a 275 watt sunlamp suspended five feet (one and a half meters) overhead; shade area is available to the tadpoles.

Uneaten food and debris are removed each evening, the water is changed, and some fresh alge is added for the night.

Figure 1
Diet Information

1. Calcium Used in Basic Vegetarian Diet and Mealworm Culture:
   Developed by Brookfield Zoo's Reptile House Staff; Instituted May 19th, 1980.
   1 part (by weight) Ascorbic Acid **
   20 parts (by weight) "Calcium Mix";
   consisting of:
   2 parts (by weight) Calcium Gluconate
   1 part (by weight) Di-Calcium Phosphate
   ** = not implicated directly in calcium metabolism.

2. Cricket Additives:
   Developed at Brookfield Zoo's Reptile House: Instituted in the fall of 1974.
   2/3 (by volume) - "Calcium Mix" (as above)
   1/3 (by volume) - Brewers Yeast (unflavored)
   Used in powdered form, mixed together and dusted unto crickets.

3. Egg Yolk Prepared for use in Water:
   Developed at Brookfield Zoo's Reptile House: Instituted June 21st, 1979.
   1 package unflavored gelatin mixed with 1-1/2 cups distilled water and heated over low heat until gelatin dissolved - stir often.

   Use 60% raw egg yolk and 40% gelatin. Mix together and cook over low heat until eggs are done - stir constantly. Spread into thin layer and chill in refrigerator. Can be kept frozen for up to six months.

Observations/Data:

When reviewing the data it is important to know that the composition of the control group changes from year to year. The original colony consisted of three founder frogs. As offspring are produced, a few adult progeny are added back to this parent colony. As a result, the control colony has grown in number and has itself become increasingly inbred. It should also be noted that the control colony is our display group and all breeding and parental care takes place while on exhibit.

In determining the average development time for tadpoles, behavioral rather than

morphological guidelines are used. The starting point is when the tadpole is transported to the water. Since the cages are serviced once a day, it is difficult to establish the exact time of hatching. Also, it is not always possible to keep track of individual tadpole identity when parental transport takes place. After the tadpole is removed from the cage and given a specific ID, individualized data is accurately recorded for each specimen. Metamorphosis would normally be considered complete when the tail has been completely reabsorbed. However, the froglets leave the water and conceal themselves in the rearing cage before this point. Therefore, we use the date that the froglet leaves the water as the day metamorphosis is complete.

TABLE 1

AVERAGE DEVELOPMENT TIME OF TADPOLES

	Control			Inbred		
Year	Time (Days)	Sample Size		Time (Days)	Sample Size	
1979	46.75	14	- same group -	46.75	14	(F_1)
1980	*	*		*	*	
1981	43	16		58.25	8	(F_2)
1982	46	2		*	*	
1983	51	9		46.75	39	(F_3)
1984	44.25	7		47.25	10	(F_4)
1985	40.50	7		50	2	(F_4)
1986	*	*		*	*	
1987	*	*		*	*	

Development time is determined from the time the tadpole enters the water until it leaves it.

* No Applicable Data.

Generally the inbred colony required longer development times than did the control colony. In 1981, the longest development time was also coupled with a comparatively high mortality rate (Table 2). The averages for the other four years are relatively close

for the inbred colony. For the control group the averages are shorter, but also less consistent from year to year, than the inbred group. In both colonies the difference between the shortest and longest average development time is almost equal (Control group = 10.5 days, Inbred group = 11 days). Because progeny are housed in the same location and as a result are exposed similarly to all environmental variables, the reason for this differential is not immediately apparent.

Mortality Rates of Tadpoles by Year:

In general, neither the control group nor the inbred group appears to have a consistent pattern to their mortality rates when compared from year to year. The control group, however, shows more consistency than the inbred group.

TABLE 2

MORTALITY RATES OF TADPOLES BY YEAR

	Control			Inbred		
Year	Mortality	Sample Size		Mortality	Sample Size	
1979	0%	14	- same group -	0%	14	(F_1)
1980	*	*		*	*	
1981	24%	21		70%	27	(F_2)
1982	40%	5		*	*	
1983	31%	13		42%	72	(F_3)
1984	33%	18		0%	10	(F_4)
1985	42%	12		0%	2	(F_4)
1986	100%	2		100%	1	(F_5)
1987	100%	4		100%	2	(F_5)

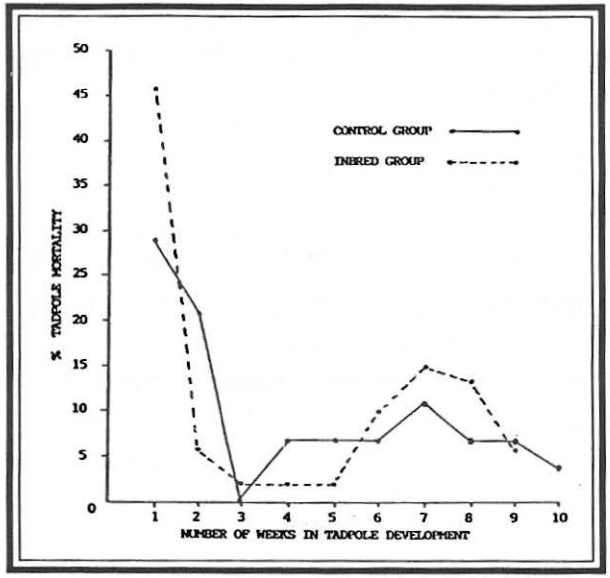
$$\text{Mortality Rate} = \frac{\text{number of tadpoles that died}}{\text{total number of tadpoles}}$$

* No Applicable Data.

Mortality Rate by Weeks of Development:

There does seem to be a pattern when mortality rate is plotted against the number

of weeks of development. There appears to have been two periods when rates were higher for both colonies. The highest mortality rate occured during the initial few weeks of development, then the rate leveled off only to rise again about the time of metamorphosis (approximately week seven).



Mortality Rate From Fungus-Like Condition:

see table 4 - next page

In 1981, a fungus like condition first appeared. On the dorsal surface of the tadpole's head, a fuzzy tuft first appeared and this then spread over the rest of the body. The body became distended, especially in the abdominal region. All affected tadpoles died within a few days of development of the condition. The fungus-like problem was absent in 1984 and 1986. We assumed that the inbred colony was more susceptible to this problem than the control colony. We discovered, however, that the control group actually suffered a greater loss.

Discussion:

The objective of our breeding program for Dendrobates auratus has been to raise several generations to observe possible effects of inbreeding. The successive generation reproduction statistics collected through the F5 generation do not seem to show any significant trends within the inbred colony towards developmental or survival difficulties when compared with the control group. In some ways the two colonies parallel each other.

One possible reason for the absence of any demonstrable difference in the two colonies performances is the fact that both colonies are inbred, one to a lessor (however random) degree than the other. The control colony may be reflecting problems similar to the inbred group but over a more prolonged period of time. If the inbred colony were

TABLE 4

MORTALITY RATE FROM FUNGUS-LIKE CONDITION

	Control			Inbred		
Year	Mortality	Sample Size		Mortality	Sample Size	
1979	0%	0	- same group -	0%	0	(F_1)
1980	*	*		*	*	
1981	40%	5		26%	19	(F_2)
1982	100%	2		*	*	
1983	25%	4		6%	30	(F_3)
1984	0%	6		0%	0	(F_4)
1985	40%	5		0%	0	(F_4)
1986	0%	2		0%	1	(F_5)
1987	0%	4		50%	2	(F_5)

$$\text{Mortality Rate} = \frac{\text{number of tadpoles that died from fungus-like condition}}{\text{number of tadpoles that died}}$$

* No Applicable Data

to be compared to a true founder group, greater differences might be apparent. It would also be more significant statistically if the sample size for both cases were higher.

At this point, we are awaiting the successful reproduction of the F5 generation. The F4 colony will be four years old this summer (1988) and has not produced any viable offspring that have been able to complete metamorphosis.

It is interesting to note that the control colony has not reproduced successfully in the last two years either. We are currently discussing whether any changes should be made in our program or if we should continue it as is. Our thinking at present is to await the death of the one remaining founder frog (now ten years old) before making any changes. This frog is still observed actively participating in breeding, tending eggs and transporting tadpoles; we would like to finish his reproductive history.

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Notice:

The next edition of this newsletter will contain a membership roster, complete with the names and addresses of all the members. If anyone has any special comments, such as restrictions on correspondence, that they would like included with their name, they should write to me as soon as possible after receiving this newsletter.

Classified Ads

Wanted: *D. histrionicus* (any color pattern) wild or CB, males or females. Contact: James R. Bondurant 1827 Haight # 151, San Francisco, CA, U.S.A. 94117. Phone # 415-386-2393

For Sale: *Dendrobates tinctorius*, imports, but established. From Guyana, w/CITES papers. Adults are 1 to 1-1/2 inches SVL. Very nice specimens - feeding. I have two color phases: yellow/blue/black and white/powder blue/ black. Both forms are selling at special price to ISSD members - $50.00 each. Limited to 15 pairs of each form, so order soon. Waiting list available for following shipment. Call Andrew at (305)-270-0419 from 12:30-6:30 PM EST.

Wanted: *D. tinctorius, D. granifularis. D. lehmanni, D. fantasticus, D. quinquevittatus, D. azureus, P. terribilis,* and *P. bicolor.* Call or write: Peter Keane - 1018 E. 226th St., Bronx, N.Y., U.S.A., 10466,: Tele # 212-655-0454.

Breeding Loan Needed: I have three female *D. histrionicus* (Bulls-eye pattern) laying infertile eggs - badly needed is the loan of a male, bulls-eye pattern first choice but will take any *D. histrionicus*. I will pay shipping and donor can have 1/3 of all F1 frogs. Call collect: Dale Bertram at 608-233-1083.

Wanted: Expedition members for the "quinquevittatus quest" - Amazonian Peru, March 1989. Permit applications take a very long time, so do not delay if you are at all interested! Badly needed is someone fluent in Spanish. Call collect: Dale Bertram at 608-233-1083.